humanaquarium: A Participatory Performance System

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ABSTRACT

humanaquarium is a self-contained, transportable performance environment that is used to stage technology-mediated interactive performances in public spaces. Drawing upon the creative practices of busking and street performance, *humanaquarium* incorporates live musicians, real-time audiovisual content generation, and frustrated total internal reflection (FTIR) technology to facilitate participatory interaction by members of the public.

Keywords

Participatory performance, frustrated total internal reflection (FTIR), multi-touch screen, collaborative interface, busking, creative practice, experience centered design, multimedia

1. INTRODUCTION

humanaquarium is an audio-visual performance project drawing on the traditions of improvisation and busking to engage passersby in the co-creation and development of a responsive performance. The '*humanaquarium*' itself is a self-contained interactive performance space, a large cubic structure which is placed in a public space where there is significant pedestrian traffic, such as a footpath or a public street (see Figure 1.) The front face of the cube is a transparent window, through which two musicians sitting inside the cube can be seen, illuminated by the light of a video projector.

Passersby are encouraged to get close to the cube, peer through at the performers, and touch the acrylic window. FTIR (Frustrated Total Internal Reflection) technology is used to detect the position of participants' hands when they make contact with the transparent surface. This touch data is used to manipulate the video imagery projected on the musicians and the interior surface of the cube, as well as to affect the musicians' timbre, instrumentation and vocal effects. By choosing to come forward and interact with the *humanaquarium* set piece, members of the public are able to join the performance frame and directly participate in shaping the performance experience in collaboration with others who are observing or taking part.

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Figure 1. *humanaquarium.*

We envisioned the humanaquarium platform as a hybrid space combining aspects of permanent theatrical spaces and improvised busking setups. The street-based art form of busking allows performers (for example, singer-songwriters accompanying themselves on portable instruments such as guitars or small drums) to situate their performance in a public area, such as a street or park. Passersby can choose to linger, observe, and form an audience for some length of time before eventually moving along to their next destination. We have created flexible and improvisational participatory compositions for the *humanaquarium* environment, allowing us as performers to respond and collaborate with our audiences and participants.

In the course of developing this project we have adopted McCarthy and Wright's experience centered approach to human-computer interface design [4]. We have therefore sought to address the creation of the artefact (the *humanaquarium* performance interface) within its sociotechnical context. By using a pragmatic framework to frame the design of *humanaquarium*, we have integrated conceptual design perspectives within our creative practice.

We begin our account with a discussion of the roles people play when participating in interactive art. We then present the conceptual and physical design of *humanaquarium,* and describe how a carefully planned system architecture facilitates ongoing refinements and enhancements to the interactive experience. We explore our method of composing performances for a participatory medium, and, finally, we conclude with a discussion of future directions for investigation in relation to *humanaquarium*'s experience centered design.

2. PARTICIPATORY PERFORMANCE

Participatory performance systems facilitate audience involvement by allowing participating audience members' behavior to modify and manipulate the development of an ongoing performance. Audience members become not passive spectators, but rather active co-creators and collaborators, shaping and developing the performance itself – directing their attention amongst one another, and affecting the development of the performance event. Benford *et al.* describe this as a manipulation of the performance frame [1], blurring the boundary between the performance and the audience.

In discussing participatory performance it is important to characterize the behavior of the people whose interactions comprise the performance frame. Sheridan et al. [6] describe this using their *Performance Triad* model, defining the behaviors people exhibit during in a participatory performance as 'performing', 'participating', and 'observing.' Each of these states of being have particular characteristics that contribute to the development of the performance.

Performers have the experience, skills and ability to communicate expressively with the art form and technology that forms the performance system. Contrastingly *participants* are novice users of the system, non-experts, and untrained with the performance environment. They choose to enter the performance frame and interact with and explore the system, but they must learn, through experience and observation, how to interact with the environment and one another. *Observers,* the spectating audience members, watch the performance but do not actively participate. They do play a role in performance development, however, either through the direct feedback they provide via applause, visible attentiveness, or simply through their very presence.

During the course of a performance, individuals may transition between or even simultaneously fulfill these roles. There is a mutual relationship between taking an action, and observing the actions of others, hence even a performer shares a similarity to a spectator.

Figure 2. Participants and performers are observed by onlooking bystanders

3. DESIGNING HUMANAQUARIUM

Our goal when designing *humanaquarium* was to increase participant engagement in this collaborative relationship between performers, participants, and observers by constructing an aesthetic experience that was enticing and entertaining in order to encourage immersion and satisfaction.

An experience centered framework developed by McCarthy and Wright [4] was used to structure and inspire the design of *humanaquarium*. When applied to the performance realm [7], pragmatic exploration is concerned not only with the content of the performance, but also with the context in which it is intended to take place. This approach is particularly attentive to the socio-technical factors that impact upon the way the aesthetics of the performance experience is perceived by those who take part. Participant experience is considered in terms of its *sensual, emotional, spatio-temporal,* and *compositional* threads. We isolated each thread of experience, and attempted to brainstorm how manipulating each thread could allow us to design humanaquarium's interface in order to maximize user engagement.

Sensual: The sensual thread refers to the way that the human senses are engaged during an experience in order to formulate a 'pre-reflective' or 'visceral' response triggered by the physical phenomena of sight, sound, smell, touch and taste. In order to reduce participants' anxiety at being observed, audio-visual elements of the *humanaquarium* performance were designed to have soothing characteristics. Hypnotic rhythms and pulsing imagery were used to relax and focus the participants. In order to tempt participants to take the risk of entering the performance frame and interacting with the installation, the *humanaquarium's* visual design was intended to be highly noticeable – the uncanny nature of a human-sized transparent-fronted cube sitting in an unexpected place was intended to attract attention and stimulate curiosity.

Emotional: The emotional thread explores the emotions arising from interpersonal relationships and social constructs in the interactive setting, and how socio-cultural values affect the perception of those taking part. When designing *humanaquarium* we decided that a physical barrier between performers and participants would provide a sense of socially appropriate personal space. This decision inspired the transparent front of the aquarium structure. As the transparent screen was also touch-responsive, it became the site of interaction, functioning as a tangible membrane where co-operation and jamming between performers and participants recognizably took place. The screen was positioned in such a way that eye contact could be established and maintained between all participants and performers while interaction was taking place. This allowed the performers to use eye contact and gesture to indicate approval and encouragement and improve the collaborative relationship between performers and participants. This configuration, with participants directing their attentions to the audio-visual content located within the *humanaquarium* structure while having their backs to the spectating audience (see Figure 2) was also designed to minimize participants' awareness of being observed.

Spatio-Temporal: The spatio-temporal thread addresses the characteristics of the space and time within which the experience takes place. When designing *humanaquarium*, we decided that a casually structured form of performance would be beneficial. Allowing participants to join the performance with the knowledge that they are free to stop participating and remove themselves whenever they choose removes a barrier of entry due to the relatively low level of commitment required. For this reason, we turned to the performance tradition of busking. We envisioned the *humanaquarium* piece as a way to facilitate laptop-based busking inside a mobile performance space, permitting passersby to observe the performance and decide when or if they choose to take part.

Compositional: The compositional thread refers to the narrative experienced by those interacting with the performance. Issues surrounding the legibility of participant interaction were of primary concern in the development of *humanaquarium*, and were addressed using various methods

related to the composition of the performance and the interface. One method of linking participant action to system feedback was to make the visible display projection directly parallel to the interactive surface, on the rear wall of the *humanaquarium*. This allowed the placement of images on the display to be recognizably controlled by where participants were touching on the screen. Responsive audio compositions were also specially created to guide participants through varying levels of complexity in order to assist them in learning the intricacies of the interface. More discussion of the compositional process in terms of legibility maximization is provided in section 5 of this document.

4. BUILDING HUMANAQUARIUM

The *humanaquarium* system is comprised of custom-built hardware pieces and an array of linkages between audio-visual software development packages.

4.1 Physical Structure

The *humanaquarium* structure is a 1.5m cube, placed directly upon the ground. The space is large enough for two performers to sit cross-legged inside, with laptops and instruments in front of them, imitating the manner of traditional street performers or buskers. The transparent front of the cube allows the performers to see and be seen by passersby, and to encourage them through gesture and eye contact to come closer and touch the screen.

4.1.1 External Case

The external case of the cube is crafted out of lightweight materials in order to facilitate ease of transportation and assembly, aligning with the intention for the *humanaquarium* to be taken to and performed in public spaces. Each wall is made of 8mm plywood, which slides inside an aluminum frame. The entire structure can be quickly dismantled and reconfigured as a flat package for ease of transport and storage.

The insides of the case are painted white, and the front and rear walls form the transparent window and projection surface. The responsive imagery that appears on the back wall of the *humanaquarium* is displayed by a projector mounted at the bottom of the front of the case. The projection is bounced off a mirror hidden on the ceiling of the case so that the performers inside do not obstruct the visualization. A camera is mounted upon the rear wall above the heads of the performers in order to have an unobstructed view of the front window for the purpose of tracking participant touches.

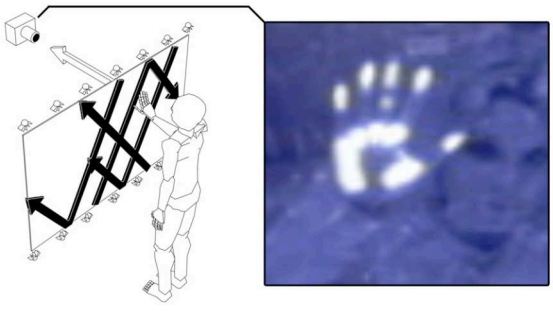

Figure 3. The IR camera-view of touches on the screen.

4.1.2 Frustrated Total Internal Reflection (FTIR)

The front screen of the aquarium is a 1.0 by 1.5m piece of 8mm acrylic. The top and bottom edges of the screen are outfitted with an array of infrared (IR) LEDs that emit a wavelength invisible to the human eye. The IR emissions are contained through total-internal reflection within the smoothly polished acrylic. When a participant touches the acrylic, the effect of his/her fingers pressing against the surface causes an effect known as frustrated total internal reflection (FTIR) to occur [3]. IR light escaping from the acrylic due to the FTIR effect is partially reflected by the finger doing the touching, and is captured by the (IR sensitive) camera mounted inside the *humanaquarium* case (see Figure 3.) To alleviate the requirement for a specialized IR camera, an IR pass filter was used in conjunction with a low-cost webcam with the hot-mirror filter removed. Image tracking software, Community Core Vision, was then run upon the webcam feed to identify multiple simultaneous touches upon the *humanaquarium* window.

FTIR technology is often used to implement multitouch surfaces, frequently seen in the form of interactive tabletops or display panels. Generally the touch responsive surface is also used as a projection surface so that imaging components of the interactive system can be used to visualize what is being touched [5]. The *humanaquarium* separates the physical situation of the touch from the perceptual results of the touch, disassociating the locations of input and output, and making our use of FTIR in a transparent window a departure from the common uses of multitouch panels.

4.2 Software Infrastructure

The *humanaquarium* software system was created in a distributed fashion, using three computers to handle the separate tasks of camera tracking, audio control, and visualization. Three software packages were used: Creative Core Vision for camera tracking, Ableton Live for real-time audio generation and sequencing, and Max/MSP/Jitter for visualization. One of the primary goals in our software development process was to ensure that behavior of the performance environment could easily be modified and adapted as we gained experience and understanding of its effectiveness through the process of performing with real participants and audiences. We created a flexible mapping model using the visual programming environment of Max/MSP to define the relationships between participant touches and system reactions, in order to decouple the dependencies between input and output.

5. COMPOSITIONAL PRACTICE

The participatory nature of *humanquarium* led us to extend our creative practice to reflect the challenges of an art form which requires the performer to relinquish a degree of authorial control and instead share the performance frame with members of the audience. When composing the audiovisual content for *humanaquarium* we developed a strategy of creative development that highlighted the interdisciplinary nature of the project. Two members of the creative team responsible for writing the *humanaquarium* performance material specialize in electronic music and multimedia art, while the third is an interaction designer with experience in non-traditional environments and interfaces. By adopting a hybrid approach to content development incorporating the methodical evaluation of interaction science and the aesthetics of the arts, our method of composition leveraged the skillsets of both the practices of multimedia art creation and human-centered interaction design. We designed *humanaquarium* to essentially be an opportunity to define each performance experience as a set of choices made within predefined aesthetic constraints. The performers led the performance by playing and singing live through a set of MIDI instruments and microphones. Input from participant touches affected the parameters controlling the orchestration and individual behavior of these instruments and audio manipulation tools essentially allowing participants to conduct and orchestrate the audiovisual experience in real time. Each

humanaquarium 'composition' was determined by the configuration of these controls and the ways by which user input could manipulate them, allowing on-the-fly reconfiguration of the performer's instruments as they played.

Together, we strategized a method of making the *humanaquarium* interface easier to learn, deciding upon a method of gradually developing the complexity of the touch screen's behavior. We segmented the screen into more discrete control regions as users became more capable with the interface, and as well increased the complexity of the associated audio-visual response by layering more controllable soundtracks as the performance progressed. Interestingly, this progression towards increased control and feedback complexity satisfied not only the necessity for a legible and learnable interface, but also our desire as musicians to make an aesthetically pleasing music composition as the introduction of musical motifs and orchestral complexity are basic constructs commonly found in contemporary music culture [2].

During the compositional process, while the media artists focused on establishing aesthetically pleasing collections of sonic and visual content, the interaction designer would apply his analytical skills to the evaluative process, experimentally mapping and remapping touch input from the screen to audible and visible parameters controlled by Ableton Live and Max/MSP/Jitter. He would explore the interactive screen, methodically testing boundary cases, and suggesting ways to make the mappings between input and output feel more satisfying and legible for novice participants. The unpredictability of these interactions from session to session led us to develop structures and themes within the music which could be reconfigured and re-ordered at will during the performance. By leaving opportunity within the composition design for us to contribute live musical content and dynamically reconfigure the audiovisual content in response to participant behavior, we were able to guide the aesthetic development of the experience using our skills as performing artists, framing open spaces for participant interaction while still maintaining a measure of creative control.

In order to improve participant enjoyment and engagement with *humanaquarium*, we scheduled a series of weekly public performances in a variety of venues. After each event, our team would compare notes on our own perceptions, our observations of the participants' behavior, and any audience feedback received. We would use these notes to inspire the agenda for each week as we composed a revised performance. This tight revision and performance loop was made possible by the deliberately flexible structure of our composition method and system architecture. We intentionally do not consider *humanaquarium* to be a finished design; rather, it provides an ongoing platform for further exploration into how to improve the participant experience.

6. CONCLUSION

Using the performance tradition of busking to ameliorate anxieties often provoked by the spatio-temporal and emotional contexts of traditional performance, and compositionally facilitating collaboration via eye contact and physical proximity to the tangible interactive surface, *humanaquarium*'s design provides a unique platform to nurture and facilitate the visible interplay between performers, participants and observers in a public setting. The design promotes a discretization between the roles of interaction via the distinct physical placement of interactors – performers in the box, participants at the screen, and spectators watching from some distance away. This discretization offers the opportunity to explore the interactive experience from a variety of figurative as well as literal perspectives in order to stimulate the phenomena of creative engagement in public spaces.

During the design process, we were inspired by McCarthy and Wright's pragmatic conceptualization of aesthetic experience, and were intentionally mindful of how we wished to influence participants via the sensual, emotional, spatio-temporal and compositional aspects of the performance. This approach to design allows us to address creative and technical requirements in a holistic fashion, as the consideration of interactive user experience is situated in a human centered grounding. This viewpoint frames a participatory performance in terms of how it is experienced by those who take part in its development.

Our roles as art practitioners and performers as well as interaction designers place us uniquely in situ during the entire design and performance process, collaborating with our participants to shape, develop, and understand a shared and co-created aesthetic experience. As we continue to refine and perform *humanaquarium*, we hope to find further opportunities for reflection upon experience and behavior in public spaces via our creative practice.

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humanquarium video content by David Green. Photography by Cassim Ladha, Touchscape.

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